Ministry of
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1986 HOT MIX COMPACTION SUMMARY

MATERIALS INFORMATION

ENGINEERING MATERIALS OFFICE

1986

HOT MIX

COMPACTION

SUMMARY

By

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SUMMARY

In 1986, the Ministry of Transportation and Communications monitored the thickness and compaction of hot mixed hot laid asphaltic concrete, placed throughout the province.

Cores were cut from completed pavement the day after placement and the lift thickness compared to design and the density compared to laboratory compaction of the same mix (% compaction). Cores were cut from main lane paving as well as 150 mm from longitudinal joints in the lane placed by the following paver, unless the pavers were paving in echelon in which case no cores were obtained.

The data was assembled and entered into a computer data base for analysis. The analysis shows that:

1) The level of compaction of main lane paving is basically the same as that achieved in the previous year 1985,

2) Compaction of the pavement 150 mm from the joint averaged 0.6 % less than main lane paving,

3) Only 53 % of main lane compaction met minimum compaction requirements,

4) The thickness of the compacted lifts exceeded design thickness by an average 2.6 mm.

A proposed bonus scheme to reward contractors for achieving superior compaction was tested against the 1986 data. The results of this test indicate the additional cost to the Ministry in 1986 would only have been around $32,000.00.

INTRODUCTION

In 1986, pavement cores were obtained from main lane and joints for laboratory testing and acceptance. The purpose of testing was to ensure that the thickness and compaction met the Ministry requirements.

The number of cores obtained in one day was dependent on the daily production(number of tonnes placed in one day). Each daily production was considered as one lot and divided to 1,2,3 or 4 sublots. Cores were cut from each lot according to the following:

Daily production (tonnes)	No. of Cores
100 to 400	1
401 to 700	2
701 to 1000	3
> 1000	4

Joint cores were taken 150 mm from the joint between two lanes in the mat placed by the following paver except when paving in echelon as defined in OPSS 310-03.

This report is a statistical summary of all the thickness and compaction data for main lane and joint cores. In addition, a proposed bonus scheme and correction factors impacts are discussed .

COMPARISION BETWEEN THE EXPECTED AND ACTUAL RESULTS

The 1986 thickness and compaction results can be summarized by the following:

1) The main lane and joints average actual thicknesses exceeded the design by 2.6 mm and 2.5 mm with standard deviations 11.3 and 9.5 respectively. These results indicate that slightly more material was used for paving than necessary.

2) The main lane average compaction was 96.1 % with a standard deviation of 2.2. This interprets to only 53 % of the main lane compaction meeting minimum requirements.

3) The joints average compaction was 95.5 % with a standard deviation of 2.1. This interprets to only 40 % of the joint compaction meeting minimum requirements.

CORRECTION FACTORS

Results from 1986 show a slightly higher mean compaction over 1985 results for all the regions. An average apparent increase of 0.85% was obtained. This percentage was achieved because of the new formula used to calculate the % compaction in 1986.

regional laboratory % compaction = [core(BRD)]/[lab(BRD)-0.023]

mobile laboratory % compaction = [core(BRD)]/{lab(BRD)-0.015]

The numbers 0.023 and 0.015 are called adjustment factors and they increase the apparent % compaction by 1% and 0.6% respectively.

If 1986 samples were tested in a regional laboratory the results appear 1 % higher than comparable cores in 1985. If a mobile laboratory was used for testing,the % compaction will appear higher by 0.6% than comparable cores in 1985.

COMPACTION BONUS SCHEME

A proposal to offer a bonus to contractors achieving superior compaction of pavement was tested on the 1986 compaction data. The bonus is intended as an incentive to the industry to achieve a greater overall level of hot mix compaction. The scheme would pay a bonus of $0.10 per tonne of mix in a lot that has 60% of the population estimate over 97% compaction. Only lots containing 3 or more sublots would qualify for this proposed scheme. The result of this analysis indicate that of 626 lots with 3 or 4 sublots, 159 would have received a bonus (25 %). Assuming that all the lots consisted of 2000 t , the extra cost to the Ministry in 1986 would have been $31,800.

Special provision #903 has been revised to implement this scheme on upcoming 1987 contracts.

DATA

The following tables and charts graphically display the regional and provincial results of 1986. In the charts, the following definitions apply.

When the lift thickness is ($30 \leq$ thickness < 40) then:

ACCEPTABLE = compaction $\geq 95\%$
BORDERLINE = $92 \leq$ compaction $< 95\%$
REJECTABLE = compaction $< 92\%$

When the lift thickness is ($40 \leq$ thickness < 55) then:

ACCEPTABLE = compaction $\geq 96\%$
BORDERLINE = $93 \leq$ compaction $< 96\%$
REJECTABLE = compaction $< 93\%$

FIGURE 1: MAIN LANE COMPACTION

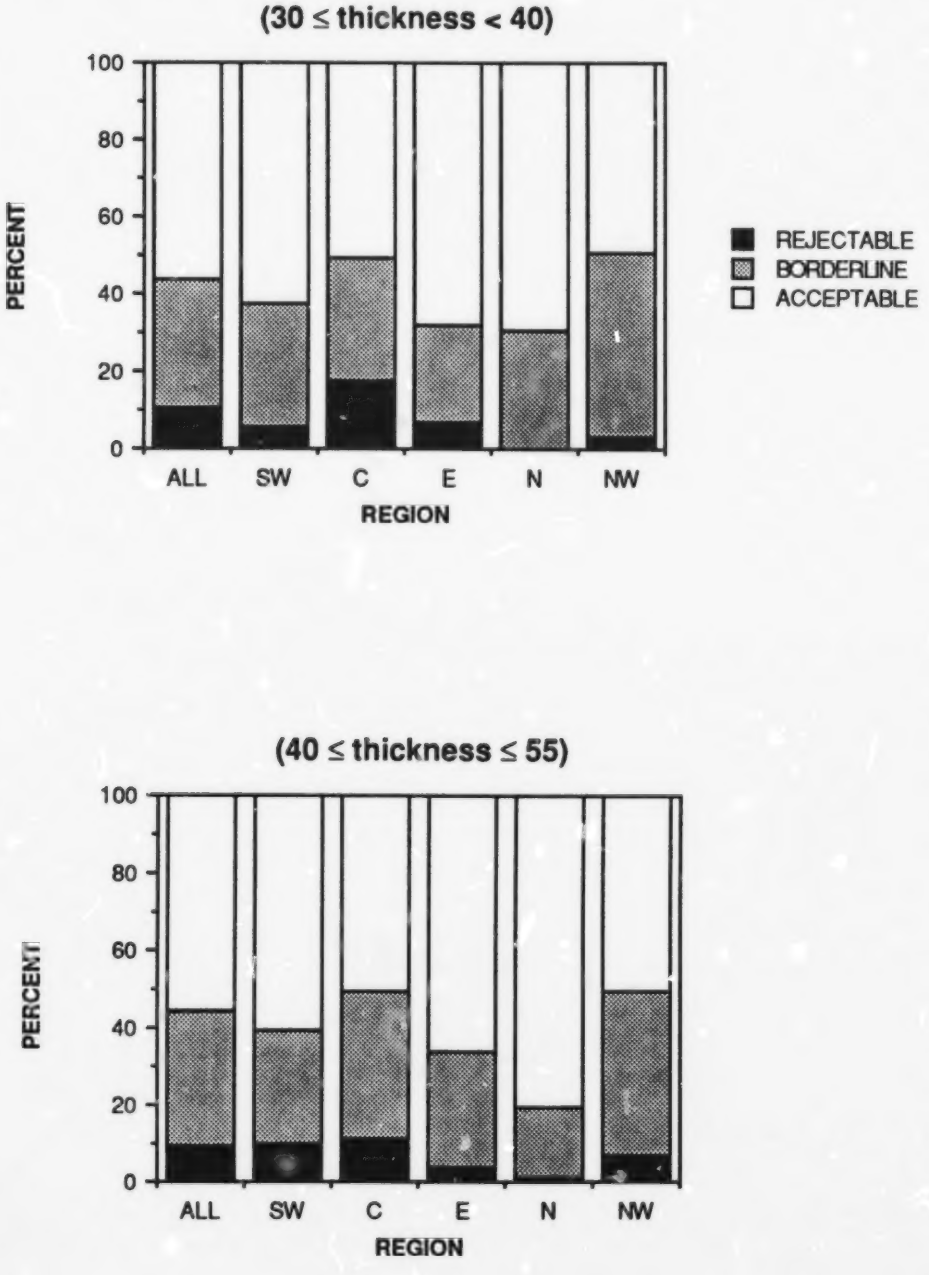


Table 1 - MAIN LANE COMPACTION--ALL REGIONS

THICKNESS OF CORES (t) mm	NUMBER OF CORES n	THICKNESS (ACTUAL-TARGET)		COMPACTION		NO. OF LOTS WITH A BONUS	NO. OF LOTS WITHOUT A BONUS
		MEAN mm	ST. DEV.	MEAN %	ST. DEV.		
ALL	2888	2.6	11.3	96.1	2.2	159	467
>55	659	12.1	15.3	97.1	2.0		
40≤t≤55	1712	2.1	6.7	96.0	2.0		
30≤t<40	481	-6.1	5.4	95.1	2.5		
t<30	36	-17.8	8.9	94.4	2.3		

Table 2 - MAIN LANE COMPACTION--SOUTHWESTERN REGION

THICKNESS OF CORES (t) mm	NUMBER OF CORES n	THICKNESS (ACTUAL-TARGET)		COMPACTION		NO. OF LOTS WITH A BONUS	NO. OF LOTS WITHOUT A BONUS
		MEAN mm	ST. DEV.	MEAN %	ST. DEV.		
ALL	509	3.1	10.5	96.1	2.2	28	87
>55	109	11.6	15.0	97.4	2.1		
40≤t≤55	268	3.7	6.5	96.1	2.1		
30≤t<40	119	-4.5	3.8	95.4	2.0		
t<30	13	-13.5	5.0	94.4	2.3		

Table 3 - MAIN LANE COMPACTION--CENTRAL REGION

THICKNESS OF CORES (t) mm	NUMBER OF CORES n	THICKNESS (ACTUAL-TARGET)		COMPACTION		NO. OF LOTS WITH A BONUS	NO. OF LOTS WITHOUT A BONUS
		MEAN mm	ST. DEV.	MEAN %	ST. DEV.		
ALL	1337	2.0	11.2	95.9	2.4	71	202
>55	358	10.1	14.3	97.2	2.0		
40≤t≤55	743	1.8	7.2	95.7	2.1		
30≤t<40	220	-6.8	5.5	94.6	2.8		
t<30	16	-21.0	10.4	94.4	2.7		

Table 4 - MAIN LANE COMPACTION--EASTERN REGION

THICKNESS OF CORES (t) mm	NUMBER OF CORES n	THICKNESS (ACTUAL-TARGET)		COMPACTION		NO. OF LOTS WITH A BONUS	NO. OF LOTS WITHOUT A BONUS
		MEAN mm	ST. DEV.	MEAN %	ST. DEV.		
ALL	371	3.6	11.8	96.2	1.9	20	55
>55	50	22.0	18.8	96.6	1.8		
40≤t≤55	259	2.6	5.5	96.4	1.8		
30≤t<40	60	-6.3	-23.0	95.4	1.9		
t<30	2	-23.0	1.4	94.3	0.7		

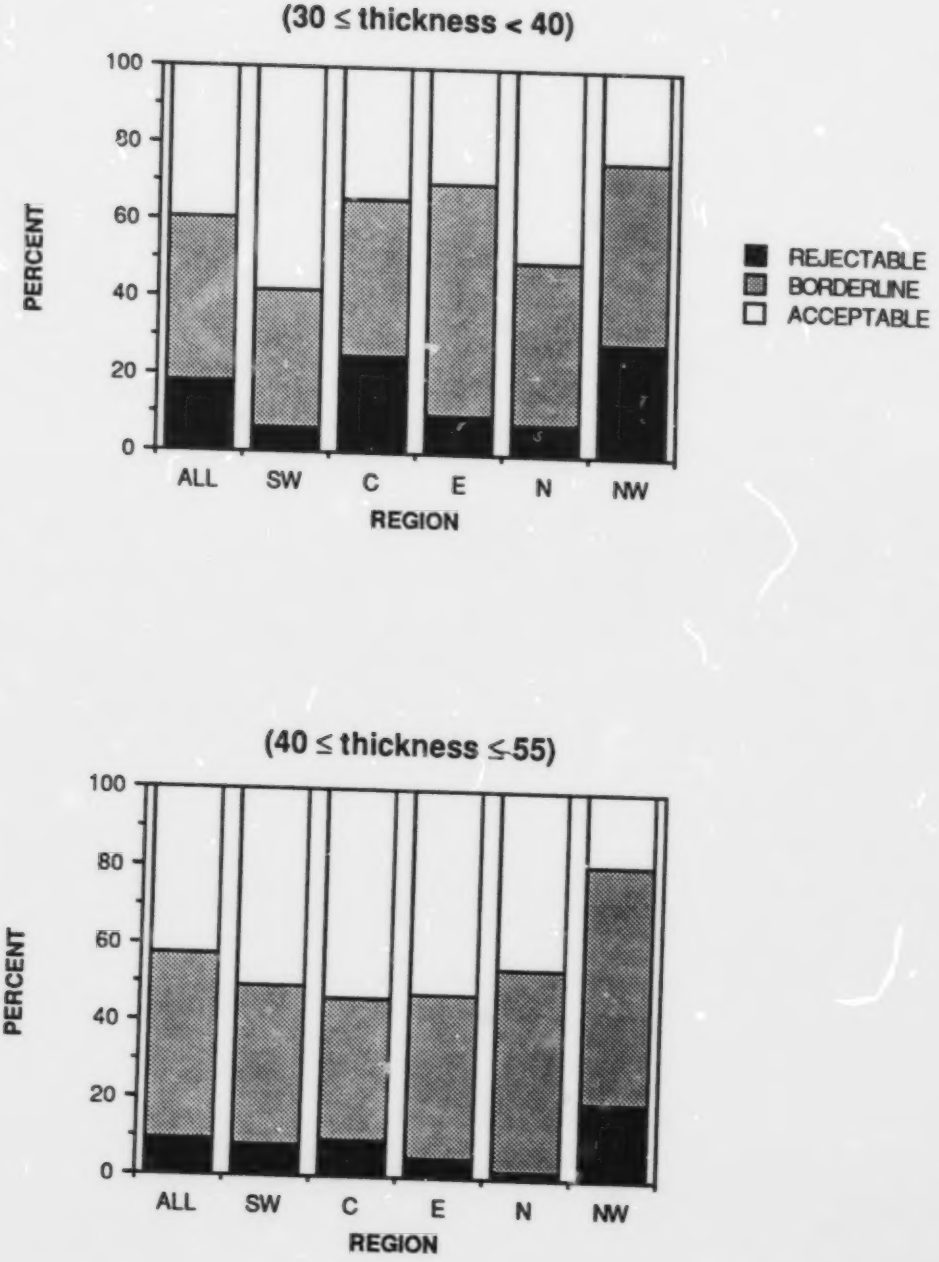
Table 5 - MAIN LANE COMPACTION--NORTHERN REGION

THICKNESS OF CORES (t) mm	NUMBER OF CORES n	THICKNESS (ACTUAL-TARGET) MEAN mm	THICKNESS (ACTUAL-TARGET) ST. DEV.	COMPACTION MEAN %	COMPACTION ST. DEV.	NO. OF LOTS WITH A BONUS	NO. OF LOTS WITHOUT A BONUS
ALL	298	3.5	12.6	97.0	1.5	28	50
>55	75	17.2	15.7	97.3	1.4		
40≤t≤55	199	-0.1	5.9	97.0	1.5		
30≤t<40	23	-9.3	6.8	96.5	2.0		
t<30	1	-24.0	-------	94.9	------		

Table 6 - MAIN LANE COMPACTION--NORTHWESTERN REGION

THICKNESS OF CORES (t) mm	NUMBER OF CORES n	THICKNESS (ACTUAL-TARGET)		COMPACTION		NO. OF LOTS WITH A BONUS	NO. OF LOTS WITHOUT A BONUS
		MEAN mm	ST. DEV.	MEAN %	ST. DEV.		
ALL	373	2.5	7.0	95.9	1.7	12	73
>55	67	11.0	4.3	96.7	1.5		
40≤t≤55	243	2.4	5.1	95.9	1.7		
30≤t<40	59	-5.3	4.0	95.2	1.7		
t<30	4	-14.8	1.9	94.5	1.6		

FIGURE 2 : JOINT COMPACTION



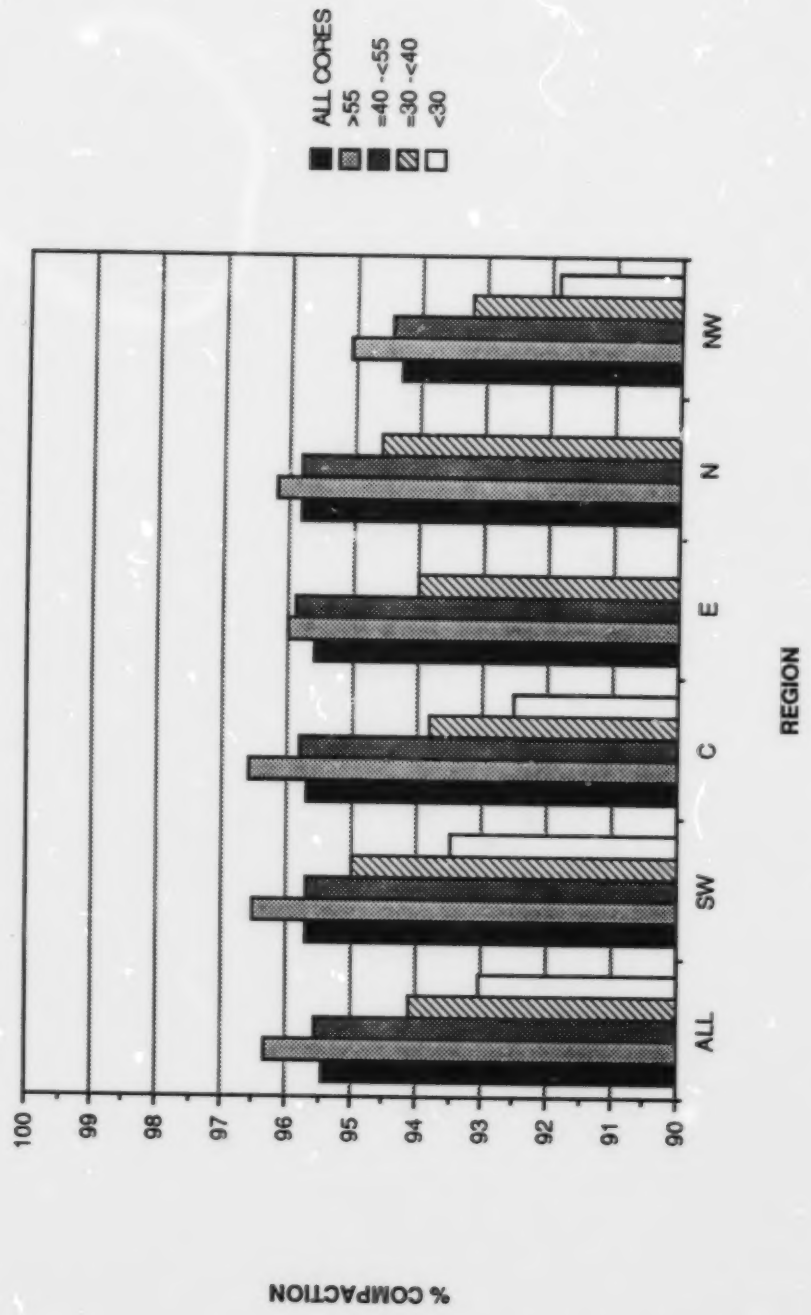


FIGURE 3 : JOINT COMPACTION vs THICKNESS

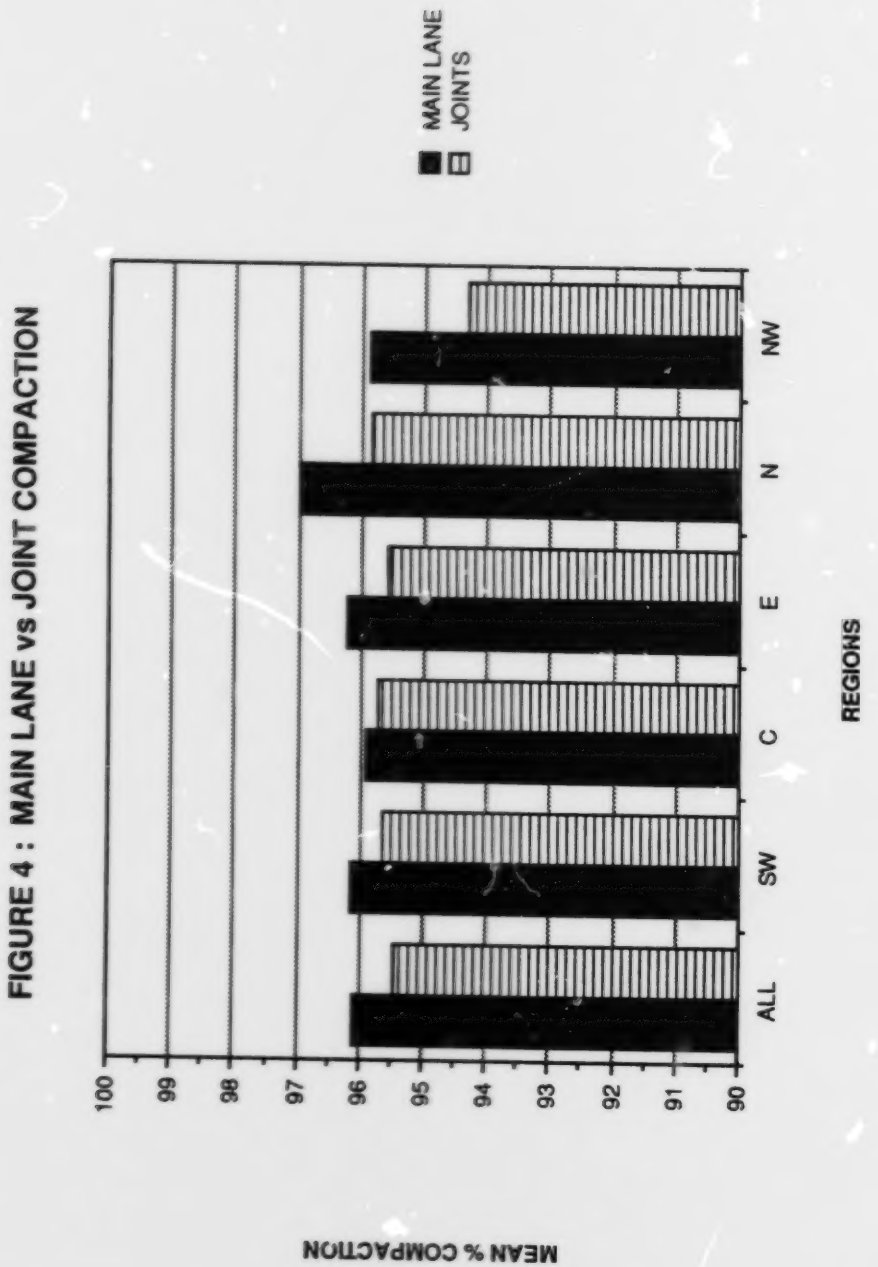


FIGURE 4 : MAIN LANE vs JOINT COMPACTION

Table 7 - JOINT COMPACTION--ALL REGIONS

THICKNESS OF CORES (t) mm	NUMBER OF CORES n	THICKNESS (ACTUAL-TARGET)		COMPACTION	
		MEAN mm	ST. DEV.	MEAN %	ST. DEV.
ALL	1148	2.5	9.5	95.5	2.1
>55	227	11.9	13.1	96.3	2.1
40≤t≤55	751	1.7	5.8	95.5	1.9
30≤t<40	156	-5.6	5.1	94.1	2.4
t<30	15	-13.3	5.6	93.0	1.7

Table 8 - JOINT COMPACTION--SOUTHWESTERN REGION

THICKNESS OF CORES (t) mm	NUMBER OF CORES n	THICKNESS (ACTUAL-TARGET		COMPACTION	
		MEAN mm	ST. DEV.	MEAN %	ST. DEV.
ALL	303	3.2	7.3	95.7	2.1
>55	40	9.6	10.5	96.5	2.5
40≤t≤55	206	4.3	4.7	95.7	2.1
30≤t<40	48	-3.9	3.7	95.0	1.8
t<30	9	-11.9	3.6	93.5	1.5

Table 9 - JOINT COMPACTION--CENTRAL REGION

THICKNESS OF CORES (t) mm	NUMBER OF CORES n	THICKNESS (ACTUAL-TARGET		COMPACTION	
		MEAN mm	ST. DEV.	MEAN %	ST. DEV.
ALL	359	3.3	11.7	95.7	2.4
>55	116	11.2	14.9	96.6	2.1
40≤t≤55	186	1.4	6.7	95.8	2.1
30≤t<40	52	-6.1	4.8	93.8	2.9
t<30	5	-15.4	8.5	92.5	2.2

Table 10 - JOINT COMPACTION--EASTERN REGION

THICKNESS OF CORES (t) mm	NUMBER OF CORES n	THICKNESS (ACTUAL-TARGET		COMPACTION	
		MEAN mm	ST. DEV.	MEAN %	ST. DEV.
ALL	56	0.9	6.6	95.6	2.5
>55	8	12.4	3.3	96.0	2.7
40≤t≤55	38	0.3	3.4	95.9	2.4
30≤t<40	10	-6.1	6.1	94.0	2.4
t<30	0	-----	-----	-----	-----

Table 11 - JOINT COMPACTION--NORTHERN REGION

THICKNESS OF CORES (t) mm	NUMBER OF CORES n	THICKNESS (ACTUAL-TARGET		COMPACTION	
		MEAN mm	ST. DEV.	MEAN %	ST. DEV.
ALL	223	0.9	10.3	95.8	1.4
>55	39	16.1	13.1	96.2	1.3
40≤t≤55	172	-1.7	5.1	95.8	1.3
30≤t<40	12	-11.5	6.1	94.6	1.8
t<30	0	-----	-----	-----	-----

Table 12 - JOINT COMPACTION--NORTHWESTERN REG'ON

THICKNESS OF CORES (t) mm	NUMBER OF CORES n	THICKNESS (ACTUAL-TARGET		COMPACTION	
		MEAN mm	ST. DEV.	MEAN %	ST. DEV.
ALL	208	2.4	7.4	94.3	1.8
>55	24	12.6	8.5	95.1	1.5
40≤t≤55	149	2.6	5.2	94.4	1.7
30≤t<40	34	-5.2	5.0	93.2	1.9
t<30	1	-15.0	-----	91.9	-----

Table 13 - COMPARISON BETWEEN 85 & 86 COMPACTION

(ALL CORES REGARDLESS OF THICKNESS)

REGION	NUMBER OF CORES	MEAN COMPACTION	%C (1986) / %C (1985)	
central				increase
1985	362	95.12		
1986	1337	95.92	1.0084	0.84%
southwestern				
1985	593	95.24		
1986	509	96.14	1.00945	0.94%
northern				
1985	334	96.29		
1986	298	97.00	1.0073	0.73%
eastern				
1985	248	95.2		
1986	371	96.21	1.0106	1.06%
northwestern				
1985	265	95.02		
1986	373	95.88	1.0091	0.86%
			SUM	= 4.43%
			MEAN	= 0.89%

FIGURE 5 : MAIN LANE BONUS CHART

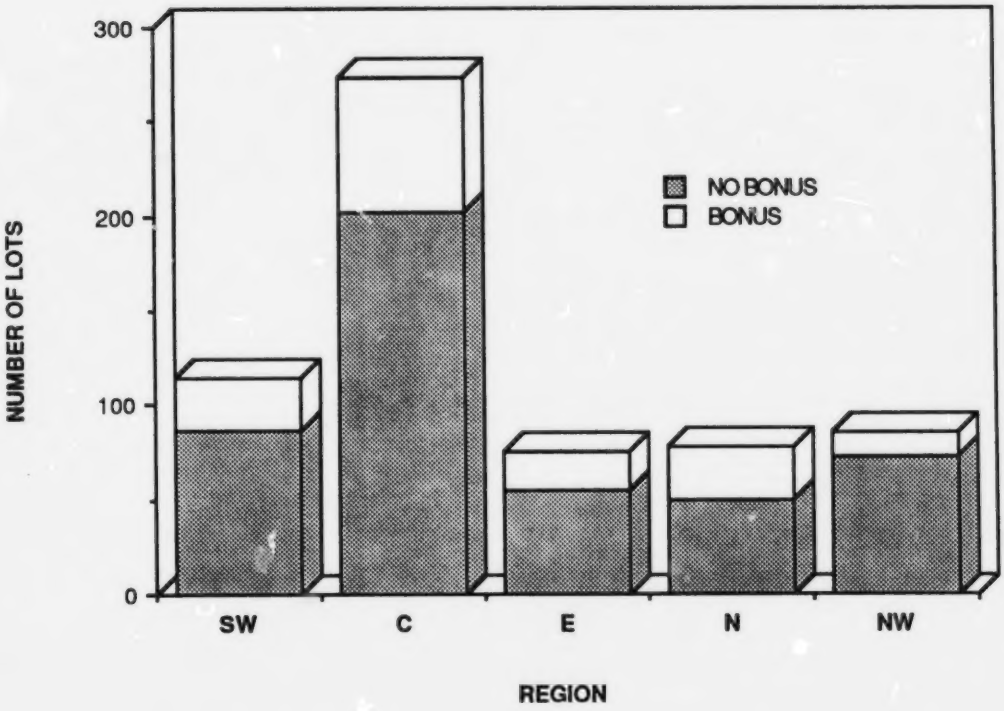


TABLE 14 : IMPACT OF BONUS ON LOTS

REGION	NO BONUS	BONUS PAYMENT
SOUTHWESTERN	87	28
CENTRAL	202	71
EASTERN	55	20
NORTHERN	50	28
NORTHWESTERN	73	12

TABLE 15 : REGIONAL AND PROVINCIAL BONUS IMPACTS

REGION	BONUS PAYMENT
SOUTHWESTERN	$5,600
CENTRAL	$14,200
EASTERN	$4,000
NORTHERN	$5,600
NORTHWESTERN	$2,400
TOTAL =	$31,800